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(54) Arrangements for Guiding Drill Bits

(57) An arrangement for guiding a drill bit (8) along a curved drilling path comprises an outer guide tube (7) in which a shaft (6) is rotatably arranged. The shaft is driven by a drive means (5) connected to one end of the shaft, whilst the bit (8) is mounted for rotation on and guided by the other end of said shaft. The axis of rotation (9) of the bit forms an angle (α) with the central axis (10) of the guide tube. The tube is non-rotatable but axially displaceable and is connected to an axially feeding device via a cladding tube (11).

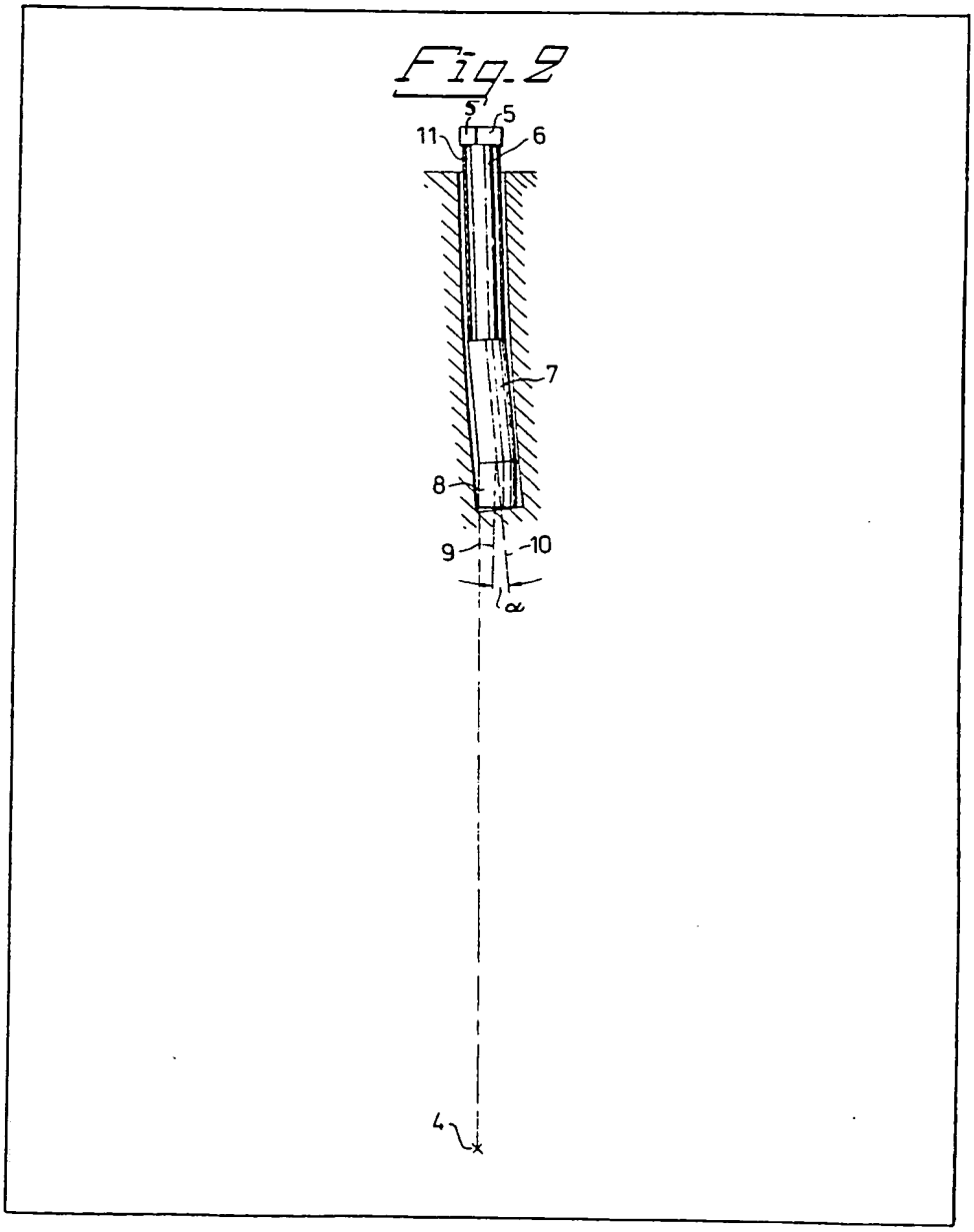

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Fig. 1

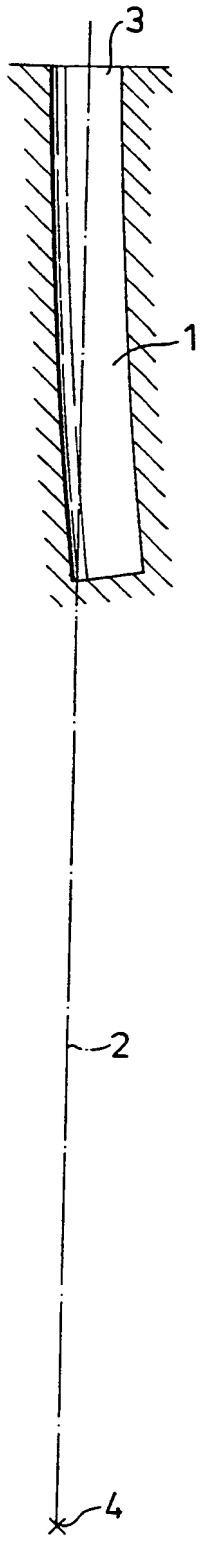


Fig. 2

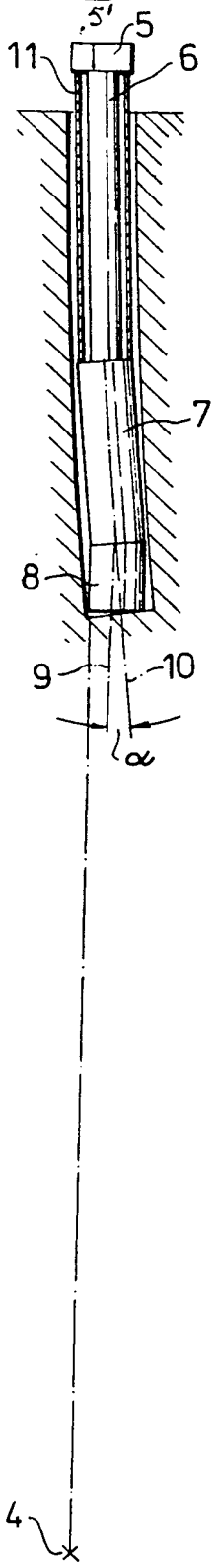


Fig. 3

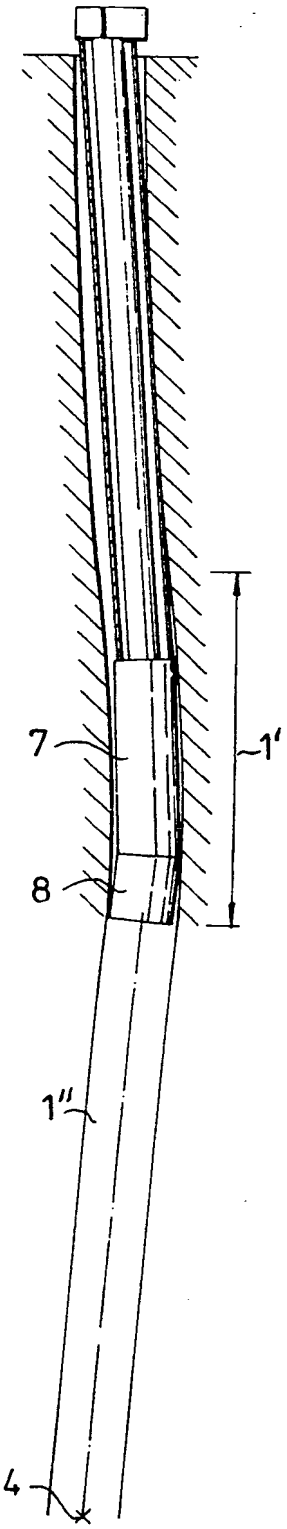
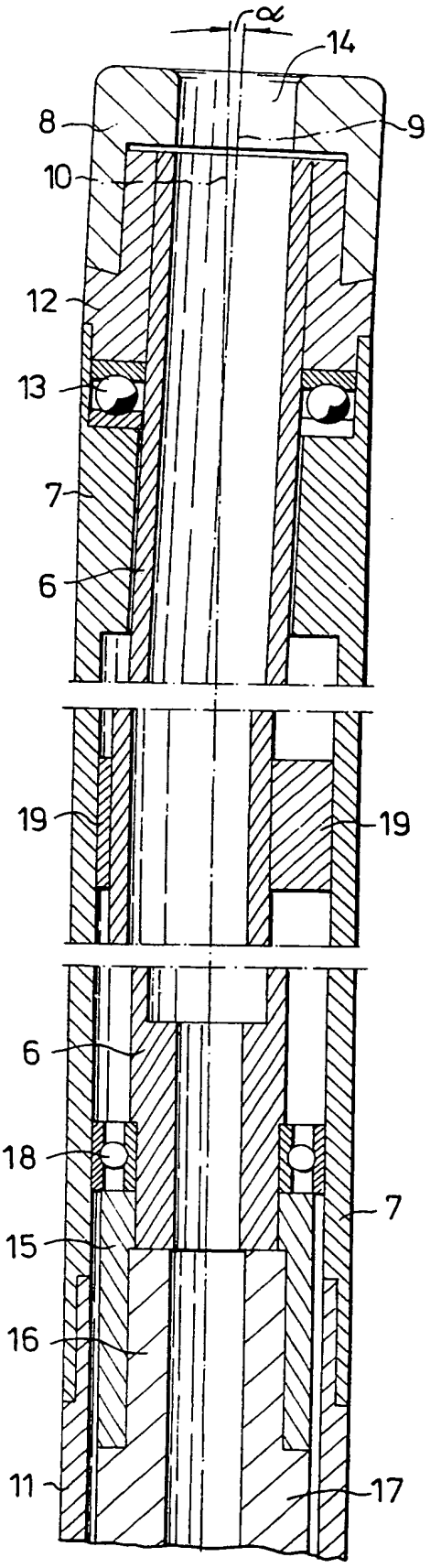


Fig. 4



SPECIFICATION

Arrangements for Guiding Drill Bits

The present invention relates to arrangements for guiding drill bits in a curved path. It is applicable to the drilling of holes in rock or in the ground.

When drilling long holes in rock or similar ground for the purpose of prospecting after ores, gas or oil, or when drilling such holes for burying electrical cables, for example for access to an underground consumer station, it is always difficult to guide the holes directly onto a given target. The extent to which these holes deviate from the said given target may sometimes be quite considerable and it is very seldom that the holes are completely straight.

Different methods and apparatus have been proposed for the purpose of counteracting or eliminating deviations from a straight line when drilling such holes, but these have not been satisfactory in the case of long drill-holes.

Consequently, the fact that the holes will deviate to quite some extent from a straight line has been accepted, and efforts have been directed to the manufacture of apparatus which will enable the direction of the drill hole to be corrected in a manner such as to reach the target.

One such apparatus arranged to produce holes which are deliberately curved is described in the U.S. Patent Specification 2 631 820.

This known apparatus is based on the use of a flexible outer guide tube and an inner, flexible drive shaft and a drill bit which has been ground in a special manner. The axis of rotation of the bit is tangential to the curvature of a curved drill hole. It is not possible with such an apparatus to guide the path travelled by the bit positively and specifically, since the bit, from a theoretical viewpoint, must continue in the tangential direction. The deviations which occur are caused by the same conditions as those deviations which occur when drilling with conventional apparatus, e.g. as a result of inhomogeneities in the rock or ground.

According to the invention, there is provided a guide arrangement for guiding a drill bit in a curved path, the arrangement comprising: an outer guide tube; and a drivable shaft arranged for rotation within said guide tube, one end of the shaft being arranged to carry the bit in a position such that the axis of rotation of the bit forms an acute angle with the longitudinal central axis of the guide tube, with the bit rotatably journalled on and guided by one end of the guide tube which is not rotated in use of the arrangement.

So that the invention will be more readily understood an exemplary embodiment of the invention will now be described with reference to the accomanying drawings, in which:

Figure 1 illustrates schematically a drill hole formed by means of conventional drilling equipment and which deviates from a given, straight line extending from the mouth of the hole to the target;

Figure 2 illustrates schematically a guide arrangement inserted in the drill hole of Figure 1;

Figure 3 illustrates schematically how the hole is corrected in a directional sense by means of the guide arrangement; and

Figure 4 is a schematic sectional view of the guide arrangement.

Figure 1 illustrates a drill hole 1 which has been drilled with conventional drilling equipment and which deviates from a desired straight line 2 which extends between the mouth 3 of the drill hole 1 and the intended target 4. In order to correct the curve in the hole 1, a guide arrangement is inserted into the hole as illustrated in a greatly simplified manner in Figure 2. The arrangement is driven by a conventional drive means 5 and has a drive shaft 6 which passes through a cylindrical guide tube 7 and carries at its lower end, as seen in the drawing, a drill bit (or boring crown) 8. Bit 8 may be, for example, a diamond bit or some other suitable type of bit and has a diameter which is slightly greater than the diameter of the cylindrical guide tube 7. The bit 8 is rotated and forced axially along the guide tube by means of the drive shaft 6. The axis 9 of rotation of the bit 8 is at an acute angle α relative to the centre axis 10 of the substantially rigid guide tube 7. The angle α may be adjusted in dependence upon the extent of the deviation to be corrected and may, for example lie within the range of 0.10 to 1.5°, although other angles are also possible. Extending around the drive shaft 6 and firmly connected to the guide tube 7 is cladding tube 11, as indicated, the upper end of which is held stationary, in the illustrated embodiment, is secured to an axial feed means 5'. The object of the cladding tube 11, which may comprise a plurality of joined sections, is partly to prevent stones and the like from reaching the drive shaft and partly to prevent rotation of the guide tube 7.

Because the guide tube 7 is held so as to be non-rotatable, it is ensured that the direction of the rotary axis 9 of the bit will be held in a given direction. When inserting the guide arrangement into the drill hole 1, the rotary axis 9 of the bit is oriented in a direction such as to correct the curvature of the drill hole and to correctly align the hole with the target 2, subsequent to drilling a little further. Figure 3 illustrates the drill hole after a small amount of drilling with the arrangement has taken place. The bit 8 has advanced over the hole section 1'. It will be apparent that the bit 8, whilst drilling the section 1' of the hole has swung in towards the line 2 in a well defined curved path determined by the angle α and that subsequent to removing the arrangement and inserting conventional drilling equipment into the hole 1, i.e. drilling equipment in which the rotary axis of the bit coincides with the centre axis of the guide tube, a straight hole 1" can be produced. Should the hole deviate from the desired straight portion 1", the guide arrangement is again inserted into the hole with the bit oriented in a manner such as to correct the deviation.

The guide arrangement is illustrated in more detail in Figure 4. The guide tube 7 and the drive shaft 6 are each divided into three sections. The guide tube 7 may have a length of 1.5 meters or a convenient length which is greater or smaller than this value. In the illustrated embodiment, the drive shaft 6 comprises a so-called core tube, which is connected in a non-rotatable manner at one end to a spindle 12 which is pivotably mounted at one end of the guide tube 7 and which is rotatable on an axial bearing 13. The spindle 12 may be fitted to the core tube 6 by means of a press-fit or a screw thread or in any other suitable means. Non-rotatably mounted on the spindle 12 (by means not shown) is the bit 8, which, in the illustrated embodiment, is a diamond bit. The bit 8 has a central opening 14 which communicates with the interior of the core tube 6. Water for rinsing away material around the bit 8 is passed through the core tube 6. The other end of the core tube 6 is provided with a sleeve 15 having, for example, a hexagonal cavity for receiving the end 16 of a drill rod 17 coupled to the drive means 5. Thus, when the drill rod 17 rotates the core tube 6 will also rotate to drive the spindle 12 and the bit 8, whilst the guide tube 7, which is non-rotatably connected to the cladding tube 11, is held stationary. In the illustrated embodiment, the oblique positioning of the bit 8 relative to the centre axis 10 of the guide tube 7, which is straight in its unloaded state, is obtained by the fact that the core tube 7 is held in a curved shape. The bearings in the guide tube for the core tube 7 are such that the rotary axis 9 of the bit and the axis of the spindle 12 form said angle α with the centre axis 10 of the guide tube. The core tube is journalled at three locations in the guide tube 7. The first location which lies nearest the spindle 12 and the bit 8 is defined by the ball bearing assembly 13 which supports the outer end portion of the core tube 6. The other end of the core tube 6 is journalled in a ball bearing assembly 18. The two ball bearing assemblies 13 and 18 hold the ends of the core tube 6 centered relative to the guide tube 7. The centre part of the core tube 6 is journalled in an eccentric slide bearing 19. Thus the core tube 6 is held curved in a given manner to determine the direction in which the rotary axis 9 of the bit 8 deviates from the centre axis 10 of the guide tube 7.

When drilling with the aforedescribed arrangement, the bit 8 will tend to describe a curved drill path in a plane containing the axes 9 and 10.

The described embodiment can be modified in various ways. Thus it is possible to use any suitable type of drill bit and constructions other than those described in order to hold the bit axis at an angle relative to the axis of the guide tube. For example, it is possible to journal the bit onto the guide tube obliquely and to use a flexible drive shaft for supplying said rotary movement and the axial force against the bit. The illustrated and described cladding tube 11, one purpose of which is to hold the guide tube fixed against rotation, can be replaced with gripping means mounted on the guide tube itself, said gripping means operating to dig into the wall of the drill hole so as to prevent rotation, whilst at the same time permitting axial movement of the guide tube.

Although the drive means 5 has been assumed to be stationarily arranged on the surface of the ground, e.g. in a drilling tower, it may also comprise a so-called sink-drill which may be incorporated in the guide tube in a manner such as to accompany the tube down into the hole.

Thus, when correcting a curved drill-hole in order to direct it towards the intended target, the guide arrangement is inserted in the drill hole with the axis of rotation of the bit directed towards the target. Then the hole is drilled further until the requisite, correction in the curve has been obtained, whereafter drilling is continued with conventional drilling equipment. Subsequent deviations are corrected in a corresponding manner.

The guide arrangement will permit holes to be drilled in a given path and to allow unintentional deviations in an uncompleted hole to be corrected. Also drill holes extending from a central drill hole can be made in given directions, for example in order to examine sand layers or the like in oil-prospecting operations.

Claims

1. A guide arrangement for guiding a drill bit in a curved path, the arrangement comprising: an outer guide tube; and a drivable shaft arranged for rotation within said guide tube, one end of the shaft being arranged to carry the bit in a position such that the axis of rotation of the bit forms an acute angle with the longitudinal central axis of the guide tube, with the bit rotatably journalled on and guided by one end of the guide tube which is not rotated in use of the arrangement.

2. An arrangement according to claim 1, wherein the drive shaft is centrally rotatably mounted at each end thereof in the guide tube and an intermediate part of the drive shaft is eccentrically rotatably mounted in said guide tube, the drive shaft being flexible.

3. An arrangement according to claim 1 wherein the drive shaft is flexible.

4. An arrangement according to any one of claims 1 to 3, wherein the bit is mounted on said one end of the guide tube via an intermediate member connected to the drive shaft.

5. An arrangement according to any one of the preceding claims wherein an axial feed device is provided for axially feeding the guide tube.

6. An arrangement according to claim 5 wherein the guide tube is connected to the feed device via in intermediate component.

7. An arrangement according to claim 6 wherein said intermediate component acts to hold the guide tube against rotation during a drilling operation.

8. An arrangement according to claim 6 or 7 wherein the intermediate component is a cladding tube.

9. A guide arrangement substantially as hereinbefore described with reference to the accompanying drawings.

10. The combination of a guide arrangement according to any one of the preceding claims and a drive means arranged for driving the shaft in rotation.

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